

The Japanese Artificially Induced Pearl.

By DR. H. LYSTER JAMESON.

ON May 4 a London evening paper announced that quantities of artificially produced Japanese pearls, of perfectly spherical shape, but containing in their centres beads of mother-of-pearl, had found their way into the London market

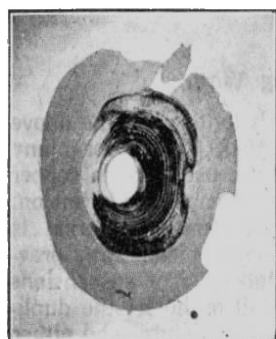


FIG. 1.—Section through the centre of a natural pearl, $\times 6\frac{1}{2}$. (Ordinary light.) Preparation and photo by Mr. A. Brammall.

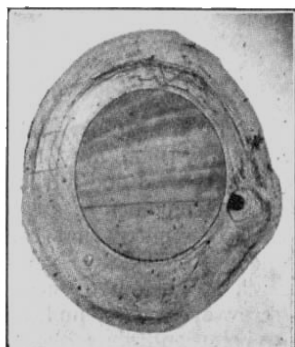


FIG. 2.—Section through the centre of a Mikimoto pearl, $\times 6\frac{1}{2}$. (Ordinary light.) Mr. A. Brammall.

and had deceived experienced pearl merchants in Hatton Garden, who had bought and resold them as naturally produced gems. Since that date many inaccurate, misleading, and contradictory announcements have appeared in the daily papers, leaving the public, both lay and scientific, in some confusion. The following statement of the position, so far as it can be judged from the scientific point of view, may therefore be useful.

For some years Mr. K. Mikimoto, the pioneer in the application of scientific knowledge to the pearl oyster on a commercial scale, has been producing in Japan, and selling under the name of "Mikimoto pearls," pearls of this description. There was no secret about this. Mr. Mikimoto not only sold them as artificially produced pearls, but also published in one of his catalogues (No. 33) a short description and diagram explaining his process.

Ever since 1898 Mr. Mikimoto (who began his work in collaboration with the late Prof. K. Mitsukuri in 1890) has been marketing half-pearls or "blisters," pearly excrescences formed by inserting a mother-of-pearl bead between the body of the oyster and the shell, and allowing the oyster to coat it over with nacre. This was, of course, merely a development of the very old operation by which the Chinese produce, in fresh-

water mussels, the well-known mother-of-pearl images of Buddha, and of Linnæus's classical experiments in the eighteenth century. These products were known as "culture pearls," and have long been familiar in this country, set in brooches, tie-pins, rings, etc. Their value, compared with real pearls of corresponding sizes, was, of course, quite small.

For many years Mr. Mikimoto experimented with a view to the production of a complete pearl, not attached to the shell, by a modification of this process, and obtained his first successful results about 1912, as announced by me at the Dundee meeting of the British Association in that year. From information supplied to me by Mr. K. Ikeda, one of Mr. Mikimoto's staff, in a letter from Tokyo dated May 30, 1914, it appears that the first considerable crop of these "round cultivated pearls" was harvested in the autumn of 1913. Their production is now an important part of the original Japanese industry.

Apart from the purely financial question as to the degree to which the advent of artificially induced pearls is likely to affect the price of natural pearls, two questions seem to have been agitating the public: Are these products "pearls"? and Can a test be devised by which, without destroying them, they can be distinguished from pearls of natural origin?

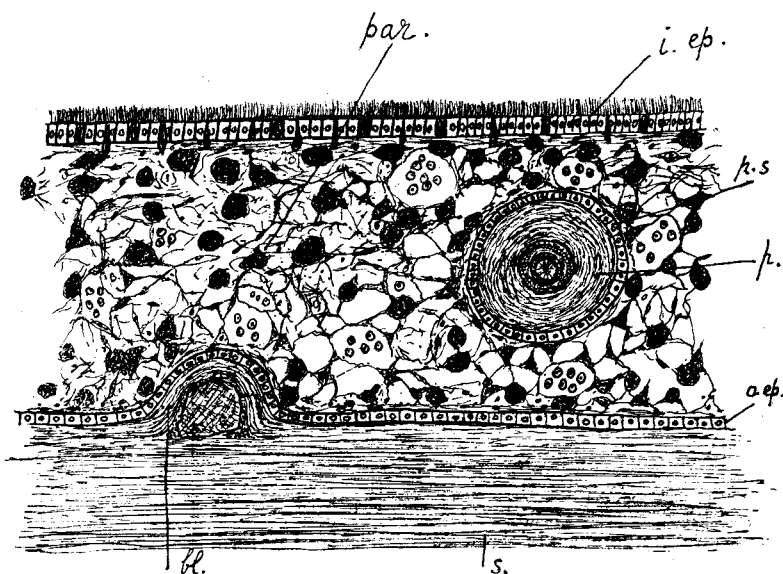


FIG. 3.—Diagram illustrating the difference between a pearl (p.) and a blister (bl.). s., substance of shell; o.ep., outer shell-secreting epidermis; p.s., pearl-sac, formed of shell-secreting epidermis; i.ep., inner ciliated epidermis of mantle cavity; par., parenchymatous connective tissue of mantle.

Of course, when a slice is cut across a natural pearl and a Mikimoto pearl the distinction is obvious. A natural pearl, except in those (in my experience exceptional) cases where a nucleus of foreign origin and of sufficient size to be identified

(such as a grain of sand) is present, consists throughout of concentrically deposited layers, which differ in degree of transparency or opacity in different specimens (Fig. 1). The Mikimoto pearl, in its outer layers, has the same structure as the natural pearl, but has an artificially manufactured bead of mother-of-pearl, composed of flat parallel laminae of nacre, in its centre (Fig. 2). (These preparations and photos were made under the supervision of Mr. Brammall, to whose investigations reference is made below.)

The method by which Mr. Mikimoto produces these pearls has been patented by him in Japan and other countries, and an application for a British patent has already been filed, and is open for inspection at the Patent Office. The information here given was obtained from this specification, from a short description and figure published in one of Mr. Mikimoto's catalogues, and from facts supplied by Mr. Toranosuke Kato, his London representative. The process involves the most delicate and skilful manipulation, and it could be carried out, presumably, only by carefully selected and trained workers. The shell is removed from one pearl oyster, and a bead of nacre or other suitable nucleus is laid on the outer shell-secreting epidermis of the mantle. This epidermis, which is composed of a single layer of cells of microscopic size, is then dissected off the oyster, and made to envelop the nucleus as a sac, the neck of which is ligatured. This sac is then transplanted into a second oyster and embedded in its sub-epidermal tissues, the ligature is removed, certain astringents or other reagents are applied to the wound, and the second oyster, with its grafted pearl sac containing the mother-of-pearl bead, is returned to the sea, where it has to remain for several years before a coating of pearl of sufficient thickness is secreted around the introduced bead. (In his letter of May 30, 1914, Mr. Ikeda stated that it took seven years.)

Now Mr. Mikimoto's success is based on the fact, which follows from my work in 1902,¹ and was further demonstrated by Alverdes's remarkable experiments ten years later,² that it is *not the presence of an irritating intrusive body that determines the formation of a pearl, but the presence in the sub-epidermal tissues of the oyster of a closed sac of the shell-secreting epidermis, the secreting surface of which is not continuous with the secreting surface of the epidermis which lays down the shell; and that unless this epidermal sac is introduced by transplantation (as in Alverdes's and Mikimoto's methods), or is induced by the specific stimulation of a particular kind of parasite (as in the pearls in Mytilus caused by the trematode Gymnophallus), or arises by some still*

unknown cause or causes (as in the Ceylon pearl oyster) no irritating body introduced into the shell or tissues can be expected to become the nucleus of a pearl. In my 1912 paper³ I showed that the vast majority of pearls from the true pearl and mother-of-pearl oysters have no recognisable nuclei of foreign origin, the bodies so often taken for such, like the dark portion of the pearl shown in Fig. 1, and the centre of the pearl diagrammatically shown in Fig. 3, being composed of a kind of shell substance of pathological origin, identical with that with which the oyster repairs an injury to its shell.⁴ On the other hand, some of the natural pearls I have examined contained foreign bodies which (apart from the special case of the trematode which causes pearl sacs to form in *Mytilus*) ranged from diatoms and fragments of radiolarian shells and sponge spicules to quartz grains measuring, in one case, as much as 0.8 mm. in diameter. I propose to outline a theory attempting to account for the presence of these bodies in a later paper.

From the biological aspect there are two classes of pearly bodies. For the first of these, to distinguish them from true pearls, I adopted the name "blisters," familiar to pearl fishers, in 1902. Blisters (Fig. 3, *bl.*) are excrescences on the interior of the shell formed to close holes made by shell-boring animals, or to coat over intrusive objects such as grains of sand, small crabs, *Fierasfer*, etc., and, in the case of the Buddha "pearls," Linnæus's "pearls," and the "half pearls" originally produced by Mr. Mikimoto, metal images or beads. Over such a blister the epidermis forms a little pocket, directly continuous with the shell-secreting epithelium. A pearl, on the other hand (Fig. 3, *p.*), is formed in a closed sac of shell-secreting epidermis, which is embedded in the tissues of the oyster, and the nacre-secreting surface of which is not continuous with that of the epidermis that lays down the shell itself. A blister is a more or less hemispherical body passing over on all sides into the shell substance; a pearl is a concentrically deposited body, the substance of which is nowhere continuous with that of the shell. A pearl may, in the course of time, be ejected into the space between mantle and shell, and become more or less buried in the shell, forming the core of a blister; but in that case it can be dissected out from the shell layers deposited over it.

The trade distinguishes different kinds of pearls according to shape and size (fine pearls, baroque pearls, seed pearls, etc.), just as biologists distinguish certain classes according to where they arise (parenchyma or mantle pearls, muscle pearls), or to the kind of shell material of

¹ Jameson, *Proceedings of the Zoological Society*, 1902, vol. i., pp. 140-66, and *NATURE*, January 22, 1903, p. 280.

² F. Alverdes, "Versuche über die künstliche Erzeugung von Mantelperlen bei *Suswassertmuscheln*," *Zool. Anzeiger*, vol. xlii., No. 10, 1913, pp. 441-58.

³ Jameson, *Proceedings of the Zoological Society*, 1912, pp. 260-358.

⁴ It is astonishing how the "foreign nucleus" theory of pearl formation sticks, as witness the utterances of scientific men of standing which have been called forth by the recent announcement.

which they are composed (nacreous pearls, columnar pearls, hypostracum pearls, periostracum pearls, hinge pearls). All these classes, some valuable, some worthless, are, from the biological point of view, pearls. Biologically speaking, the Mikimoto pearl satisfies all the conditions which go to make up a pearl as defined above. It differs from a natural pearl only in that it contains a foreign nucleus larger than any foreign nucleus which I have so far encountered in a natural pearl, and in that this nucleus is a bead of mother-of-pearl such as does not occur in Nature. Both these points could easily be remedied. A smaller nucleus could be introduced; or the nucleus might be removed after grafting the sac in the oyster; or a small natural pearl of inferior quality, or a concentrically crystallised bead of carbonate of lime, could be used as a nucleus. A trade in the worthless pearls of *Mytilus* might even be revived for this purpose; according to Garner they were once exported from this country to China for the manufacture of "medicine." The somewhat greater transparency, on the average, of Mikimoto pearls, when compared with natural pearls, could be remedied by either of these processes.

With regard to the question of distinguishing the Mikimoto pearl without cutting it, much vague talk as to scientific investigations has appeared in the daily Press. Some of these investigations remind me of the little boy who, having learned that trains were propelled by steam, lighted a fire in his go-cart, put a kettle on it, and expected it to run by itself. Undoubtedly experienced pearl merchants, and, indeed, any zoologist who is familiar with the shells of the different species and geographical races of pearl and mother-of-pearl oysters, can usually distinguish pearls from the Japanese pearl oyster (*Margaritifera Martensii*) from the pearls of other species, just as they can distinguish Ceylon, Australian, Central American, etc., pearls from each other by slight differences in colour and lustre; but this test only reveals that the pearls come from the Japanese pearl oyster, and cannot be used to distinguish naturally and artificially produced Japanese pearls from each other; and it would be useless for distinguishing pearls produced by the Japanese process in other species of pearl oysters from pearls naturally produced by the same species.

This natural difference is greatly intensified when the pearls are examined in ultra-violet light, for which purpose an apparatus has been designed and is already on the market. I hope shortly to be able to examine some naturally produced Japanese pearls with this apparatus. I anticipate that they will agree with the artificially produced Japanese pearls, and not with natural pearls from other localities, as this test, like the rule-of-thumb test based on the general colour and lustre,

appears to depend on the minute differences in the structure of the nacre in different species and races of pearl oysters.

Immediately on the first announcement of the presence of these pearls in the market being made, I suggested to a Press representative who called upon me that polarised light was the most hopeful line along which to seek a test that would reveal the presence of the artificial nucleus, and this suggestion was published in one of the daily papers on May 5. Immediately afterwards I got into communication with Mr. A. Brammall, of the Imperial College of Science and Technology, South Kensington, who has since been engaged upon experiments which aim at determining whether polarised light can be applied to whole pearls in such a way as to furnish a test.

The behaviour of polarised light when passed through sections of the natural and the Mikimoto pearl respectively was a foregone conclusion from our knowledge of the structure of their centres. When examined with polarised light between crossed Nicols, the section of a natural pearl, of course, shows throughout the cross of extinction characteristic of concentrically crystallised bodies (except in those parts which are too opaque to transmit light). A section of a Mikimoto pearl, on the other hand, shows the four arms of the cross in the outer part, which is concentrically laid down; but the mother-of-pearl bead appears alternately dark and light as the slide is rotated, according as the part of the exterior to which its laminae are parallel is in a dark or a light sector. Mr. Brammall is not yet in a position to make a definite statement as to the practicability or otherwise of applying some modification of this process to the whole pearl. He will, of course, publish his results as soon as they are completed.

However, whether or not the pearls, produced by the Mikimoto process, which are now on the market, can be distinguished from naturally produced pearls, without destroying them, by virtue of their containing a large bead of mother-of-pearl, which behaves differently towards polarised light or towards some other variety of light, Mr. Mikimoto can easily remedy this in future by a modification of his process, such, for example, as one of those suggested above. That being so, and having in view the fact that, in the appropriate localities, "Oriental," Australian, Central American, and other varieties of pearls could be produced by the same process, it is probable that, as time goes on, more and more of the pearls coming into the market will have been produced, not by the old-fashioned methods of fishing for the "wild" pearl oyster, some of which methods have existed almost unchanged from time immemorial, but by such applications of scientific knowledge to cultivated pearl oysters as that in which Japan has given so conspicuous a lead.